

EVAPOTRANSPIRATION SYSTEMS

Description. A sand and gravel bed contained within an impervious lining, which receives septic tank effluent and in which evapotranspiration through the surface of the sand and/or plant life is the sole means of effluent removal.

Conditions for Approval.

1. The site must not be subject to flooding.
2. High groundwater, seasonal or normal, must not come within six (6) inches of the bottom of the impervious liner.
3. Evapotranspiration systems may be approved where soils are very thin, impermeable or very coarse.
4. The adjusted growing season (March-October) evapotranspiration at the site must exceed the ten year return frequency annual precipitation.
5. The slope must not exceed twelve (12) percent.
6. The setback from surface water may be reduced to 100 feet if the system is constructed with a minimum of a 30 mil PVC, 60 mil HDPE liner equivalent geosynthetic clay liner.
7. The ET System must have a minimum of 100 feet separation to any Domestic or Public well.

Design.

1. Area: $T_{area} = nV / (GS_{ET} - P)$

Where:

T_{area} = Total horizontal area in square feet.

n = Peaking factor, varies from 1 to 1.6, per EPA/625/R-00/008, TFS-31.

V = Annual volume of received effluent, in cubic feet.

GS_{ET} = Annual growing season (March-October) reference evapotranspiration, adjusted for the vegetation planted on the bed, in feet.

P = Annual precipitation, in feet, with a return frequency of 10 years.

2. Total Bed Depth (T_{bd}). Total Bed Depth will be determined from a water mass balance beginning with October (See form at the end of this section). No credit is given for evaporation occurring between November and February.
 - a. The total bed depth includes:
 - i. The vertical distance from the ground surface to the bottom of the laterals which should be no greater than 1 foot plus the lateral pipe diameter.
 - ii. The vertical distance from the bottom of the laterals to the highest calculated saturated effluent depth which should be no less than 0.5 feet.
 - iii. The total vertical distance from the ground surface to bottom of the impermeable liner should not exceed 4 feet.

See Evapotranspiration Cross-Section diagram below.

3. A high water alarm shall be installed. This high water alarm shall indicate when the effluent level in the ET System reaches the bottom of the laterals. The alarm shall be both audible and visible. The alarm relay shall be latching, requiring the owner/operator/service personnel to physically inspect the effluent level in order to reset the alarm.

System Sizing Procedure.

- (A) Determine annual precipitation with a ten year return frequency using annual precipitation data from Idaho Climate at <http://www.wrcc.dri.edu/summary/climsmid.html> in feet per month. The frequency analysis can be done using the log Pearson III method described at: <http://water.oregonstate.edu/streamflow/analysis/floodfreq/index.htm#log>. A web-based calculator for this method can be found at:

<http://octavian.sdsu.edu/~ponce/pearson/pearsonform.html>

The monthly precipitation distribution can be obtained using the long-term monthly averages for the climatological site in question along with the long-term average annual precipitation. The monthly precipitation distribution and calculated annual precipitation are then used to calculate monthly precipitation rate (A).

- (B) Effluent Depth = days/month * daily flow, in cubic feet/month/surface area.

$$B = \frac{X \text{ Gallons/Day} * Y \text{ Days/Month} * 0.1337 \text{ ft}^3/\text{Gallon}}{T_{\text{area}} \text{ ft}^2}$$

- (C) Determine evapotranspiration in feet per month from average growing season (March-October) reference evapotranspiration (ET_r) for the station nearest the proposed project. Resources which provide this information include the Agrimet network at:

<http://www.usbr.gov/pn/agrimet/monthlyet.html>

and the Kimberley Research and Extension station for the University of Idaho at:

<http://www.kimberly.uidaho.edu/water/appndxet/index.shtml>

The ET_r value should be adjusted for the water use efficiency of typical plant species used on the ET bed by multiplying by the crop coefficient of 0.7:

$$C = 0.7 * ET_r$$

- (D) Δ Storage = effluent depth + [precipitation - evapotranspiration_{adjusted}]:

$$D_{\text{Mar}} = B_{\text{Mar}} + (A_{\text{Mar}} - C_{\text{Mar}})$$

$$D_{\text{Apr}} = \dots$$

$$D_{\text{Oct}} = B_{\text{Oct}} + (A_{\text{Oct}} - C_{\text{Oct}})$$

- (E) Determine the cumulative storage by adding each previous month.

$$E = D_{\text{Oct}} + D_{\text{Nov}} + \dots + D_{\text{Sept}}$$

Determine E_{max}, the largest value of cumulative storage needed during the annual cycle.

- (F) Determine the total bed depth to prevent overflow. Calculate the saturated bed depth (F). Since the bed is filled with sand, the total bed is not available for storage. An average holding capacity of thirty five (35) percent should be used. The Saturated Bed Depth (ft):

$$F = \frac{E_{\text{max}}}{0.35}$$

- (G) Finally, calculate the total bed depth, T_{bd}, by adding the minimum vertical distance from the top of the maximum saturated bed depth to the ground surface to the saturated bed depth (F). If the total bed depth is greater than four feet then the area of the ET bed should be increased to add the required volume in order to keep the ET bed maximum depth at 4 feet or less.

Construction.

1. A appropriately sized septic tank must be placed prior to the ET System to provide primary clarification.
2. The bed must be lined with an impervious liner approved by the Department. Synthetic liners must be imbedded in sand, free of sharp stones, with at least four (4) inches of bedding

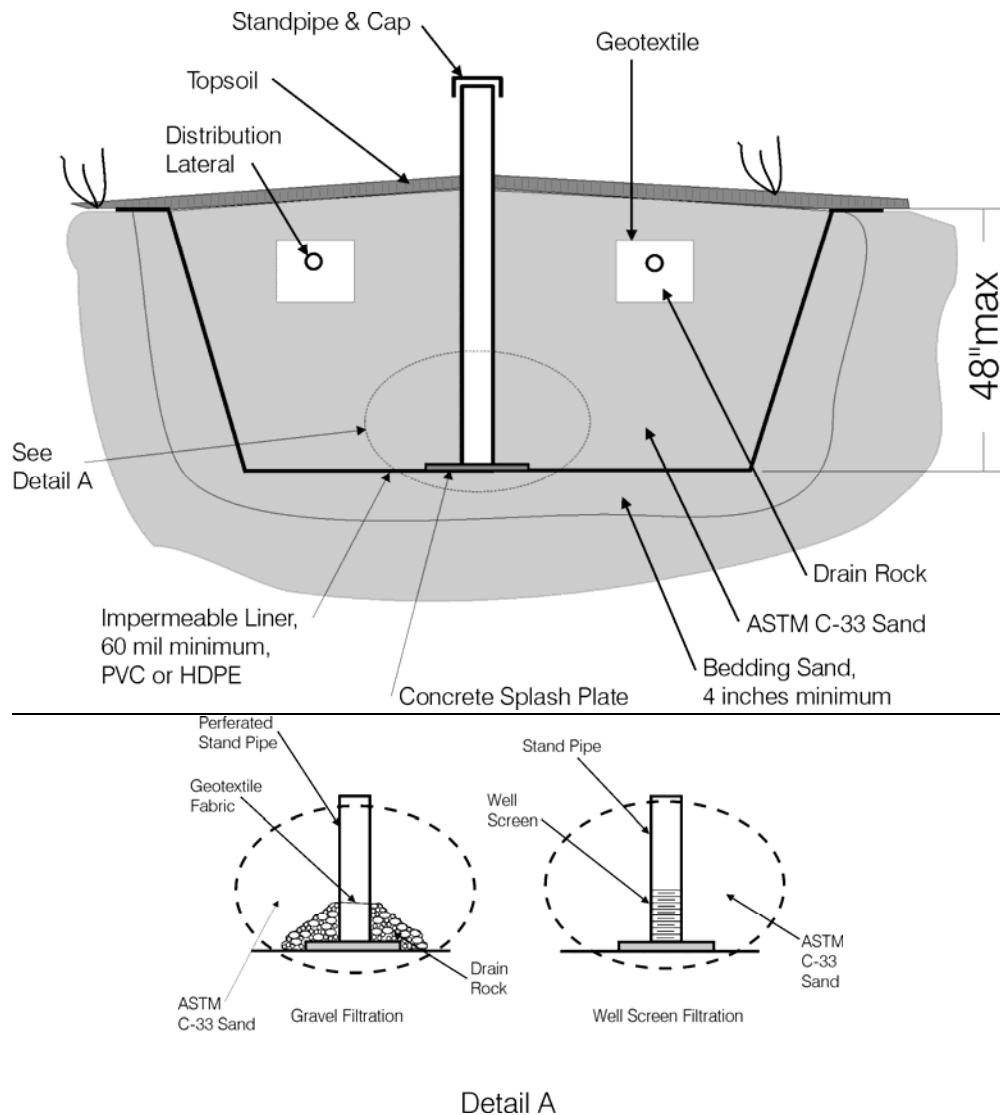
sand between the liner and the natural soils. The liners must be bonded per manufacturer's recommended procedures.

3. The bed is filled with modified ASTM C-33 sand, the modification is the exclusion of all materials passing the 100 sieve. The sand should be crowned at two (2) to three (3) percent to establish a slope for precipitation and snow melt runoff.
4. Distribution laterals must be placed in one (1) foot by one (1) foot drain rock trenches constructed in the sand layer. The piping should be looped, and spaced in order to provide uniform effluent distribution.
5. The drain rock shall be wrapped in Geotextile.
6. A four (4) to six (6) inch layer of sandy loam topsoil must be placed directly on the sand of the bed, matching the slope specified for the modified ASTM C-33 sand.
7. An eight (8") inch minimum diameter standpipe shall be installed in the center of the bed. The standpipe shall extend down to the splash plate and shall extend above the topsoil a minimum of six inches. The purpose of the standpipe is to monitor effluent levels in the bed, provide access for maintenance pumping to reduce the salinity levels in the bed, and to provide access for emergency situations to prevent surfacing of effluent. If the ET System has an Aspect Ratio (AR), which is the ratio of length (L) to width (W), greater than two (2), then multiple standpipes will be required so that the distance separating each standpipe does not exceed the width of the ET System, and the number of standpipes required is an equal multiple of the width (W).
8. the ET System's liner must be leak tested after inserting the modified ASTM C-33 sand. The liner must pass the leak test in order to successfully pass the final inspection and receive authorization to be put in used by the Health District.
9. The finished bed should be planted with a combination of both shallow and deep rooting perennials. The species chosen, particularly the deep-rooted species, should be tolerant of elevated salinity levels. Small, salt tolerant shrubs are acceptable, but large trees and other deep rooted plants are prohibited. Plants shall be planted prior to system use, and according to an acceptable planting schedule that will minimize plant die-off due to lack of water, excessive heat or cold, or other detrimental condition.
10. The ET System should be fenced, or placed in a location that prevents small children or pets from accessing its surface.

Operations & Maintenance Requirements.

1. Fertilizing the ET system is not required.
2. Irrigation of the ET system is not required, but may be allowed during prolonged droughts or periods of excessive heat to maintain a healthy plant population. At no time should irrigation become a significant contributor to the liquid in the system.
3. Monthly monitoring and recording of the ET System's effluent depth is required for the first year. Subsequent years can be monitored and recorded on a quarterly basis. Annual data shall be submitted to the appropriate Health District.
 - a. Unexpected effluent depth shall be immediately reported to the Health District. The Health District shall assist the owner in finding the appropriate corrective action.
 - i. A lack of effluent may indicate a leaking system.
 - ii. Excessive effluent, indicated by the alarm activating multiple times, may indicate excessive water usage, leaking toilet, or irrigation of the system.
4. Periodic surface maintenance may be required.

- a. In the summer, if the surface contains grasses, they should be mowed periodically, and the clipping removed and disposed of with other yard refuse.
 - b. Autumn maintenance may include gently spreading leaves over the surface, and allowing the resident flora to die back. Removal of the refuse is not necessary. A thin layer of leaves will provide a thermal blanket that will keep the ET System from freezing during the winter.
 - c. No maintenance is foreseen for winter operation.
 - d. Spring maintenance may require removal of cover to allow the new growth the best opportunity to access light.
5. A pool test kit may be used to monitor effluent salinity. It is recommended that salinity tests be conducted at the end of the summer or early autumn. Record the value along with the effluent depth. Plants showing signs of stress may indicate excess salinity in the ET System.
6. Periodic pumping and flushing of the ET System may be required to prevent excessive build up of salinity. Excessively saline soils will inhibit plant growth, and could reduce evaporation from the ET System. The ET System should be pumped concurrently with the septic tank maintenance every three (3) to seven (7) years.



WATER MASS BALANCE TABLE

Month	Precipitation Rate	Effluent Depth	ET	Δ Storage	Cumulative Storage	Saturated Bed Depth
	A	B	C	D	E	F
Oct.						
Nov.						
Dec.						
Jan.						
Feb.						
March						
April						
May						
June						
July						
Aug.						
Sept.						

Start with the first month in which storage will be positive. In Idaho, that is usually October.

Notes.

1. Ion Exchange Water Softeners, those that use Salt (Sodium or Potassium Chlorides), are not recommended for discharge to ET Systems due to excessively quick salt buildup. If water softeners are used in the home, pumping and flushing of the ET System may be required as often as every other year to prevent stressing the plants, and building up an impermeable salt layer inside the ET System.
2. Unless the net evaporation (the difference between total precipitation and evaporation) is very large, evapotranspiration systems may be impractical. At Kuna, Idaho, where the net evaporation is 25 inches per year, a system for a three-bedroom home may exceed 10,000 square feet and have a diameter exceeding 120 feet, or a square of about 105 feet on a side.
3. No substantiating evidence is currently available to support reduction of ETA design below that which is provided herein.
4. Sources for recommended plants for populating the ETS surface may include, but not be limited to:
 - a. The NRCS,
 - b. University of Idaho Agricultural Extension, or
 - c. Rocky Mountain Native Plant Company, 3780 Silt Mesa Rd, Rifle, Co 81650

EXAMPLE ET SYSTEM CALCULATION:

COLUMN A CALCULATIONS:

1. Go to the Desert Research Institute's Idaho climate summary website at

<http://www.wrcc.dri.edu/summary/climsmid.html>.

Once there, select one of the 152 statewide sites located nearest the proposed ET system site. The first page is the Period of Record Monthly Climate Summary. Record the 12 monthly average total precipitation values and the total annual precipitation value from this page. Divide each month's average precipitation by the annual total and record the resulting value as the Monthly Precipitation Contribution (MPC).

$$MPC_{Jan} = \text{Monthly_Average}_{Jan} / \sum_{X=Jan}^{Dec} \text{Monthly_Average}_X$$

$$MPC_X = \dots$$

$$MPC_{Dec} = \text{Monthly_Average}_{Dec} / \sum_{X=Jan}^{Dec} \text{Monthly_Average}_X$$

2. In the left column of this website, scroll down to the 'Precipitation' heading and select the 'Monthly Totals' under the Monthly Precipitation Listings. This will provide the Monthly Total Precipitation table (in inches) for the selected site's period of record. Evaluate the provided monthly average data, omitting any annual total if any one (1) month shows more than 3 days of data missing. Identify the remaining years of acceptable data, count the total number of valid points (# of Annual average values) and then go to the San Diego State University website (<http://octavian.sdsu.edu/~ponce/pearson/pearsonform.html>) providing the online Log Pearson III calculator.
 - a. Indicate that the data is NOT in SI units.
 - b. Indicate the number of years of average annual precipitation data you have.
 - c. Enter the data, each value separated by a single space, in the row requesting 'flood series Q_i '. The number of annual data values must equal the number of years you entered in (b).
 - d. Click on the "Execute" button. Your results will appear in a new window. Your input data will appear first, followed by the results. Find and record the $Q_{10\text{-yr}}$ value.
3. Multiply the $Q_{10\text{-yr}}$ value by each month's MPC, calculated in step 1 above. Record these values in Column A, of the Water Mass Balance table, in each month's row.

COLUMN B CALCULATIONS:

4. Monthly accumulation of wastewater:
 - a. Obtain the average daily wastewater flow for the home as specified in Rule (IDAPA 58.01.03.007.08); i.e. X = 3 bedroom home = 250 GPD. Add or subtract 50 GPD for each bedroom deviating from 3.
 - b. Multiply:
 - i. The home's average daily wastewater flow (X gallons per day), by the number of days in the month under consideration, yielding gallons per month.
 - ii. Convert each month's result to ft^3/month by multiplying by $0.1337 \text{ ft}^3/\text{gallon}$.
 - iii. Multiply the ft^3/month value by your chosen Peaking Factor (PF). [$1.0 \leq \text{PF} \leq 1.6$].
 - iv. Divide this product by an initial estimated ET system area (T_{area}). Initially start at 7,500 square feet for a 3 bedroom home, and vary the size by 1,000 square feet for each bedroom above or below the 3 bedroom value.
 - c. Record the resulting effluent depth in column B for the month under consideration.

COLUMN C CALCULATIONS:

5. Evapotranspiration values can be obtained from either the AgriMet website, from the Pacific Northwest Cooperative Agricultural Weather Network, or from the University of Idaho's Kimberley Research and Extension Station website.
 - a. If you choose to use the AgriMet data;
 - i. The values supplied are in Inches/Month.
 1. Divide each month's value by 12 inches/foot to obtain Foot/Month.
 - ii. Use only the data for March through October and multiply each monthly value by the 0.7 adjustment factor to account for vegetation different from alfalfa. Alfalfa is the crop used to develop the AgriMet data.
 - iii. Record the result for each month in that month's row under Column C.
 - b. If you choose to use the Kimberly Research and Extension Station data, choose a crop, typically pasture grass;
 - i. The values supplied are in Millimeters per Day (mm/day).
 1. Multiply each value by the number of days in that month to obtain mm/month.
 2. Divide the mm/month value by 25.4 mm/inch to obtain inches/month.
 3. Divide the inches/month value by 12 in/ft to obtain feet/month.
 - ii. Multiply each month's result by the crop conversion factor of 0.7.
 - iii. Record the result for each month in that month's row under Column C.

COLUMN D CALCULATIONS:

6. Calculate the change in storage (Δ Storage) for each month. This will require that you add the Precipitation, column A, to the effluent generated in the house, column B. Finally, subtract the Evapotranspiration, column C, and record the result for each month in column D.

COLUMN E CALCULATIONS:

7. To complete column E first start by copying the value for October from column D into column E.
8. Add the column D value for the next month to the previous month's value in column E. Record this value in column E
9. Repeat step 8 for all 12 months.

$$E_{Oct} = D_{Oct}$$

$$E_{Nov} = E_{Oct} + D_{Nov}$$

$$E_{Dec} = \dots$$

$$E_{Sept} = E_{Aug} + D_{Sept}$$

COLUMN F CALCULATIONS:

10. Divide each month's Cumulative Storage value in column E by the porosity of the bulk material that the Evapotranspiration system is made of. Typically, the ASTM C-33 sand has a porosity of 35% (0.35). If the monthly value in column E is less than zero (0), put zero in F.

$$F_{Oct} = E_{Oct} / 0.35$$

11. Identify the largest value in column F. This should occur in the spring, just prior to the start of the growing season. This value must be less than two and one-half (2.5') feet in order to accommodate the one and one-half (1.5') feet of overburden top soil and not exceed a maximum system depth of four (4') feet.
12. If the maximum depth is greater than two and one-half (2.5') feet, increase the system's surface area and recalculate.

13. If the maximum depth is less than two and one-half (2.5') feet, decrease the system's surface area and recalculate.
14. Repeat this process until a surface area is identified that yields a saturated bed depth of two and one-half (2.5') feet for the site's specific precipitation and evaporation characteristics when coupled with the future home's proposed wastewater generation rate.
15. If a suitable sized Evapotranspiration system is not determined, then
 - a. Vary the Peaking Factor, but do not go below a Peaking Factor of one ($PF \geq 1$).
 - b. Vary the number of bedrooms in the home.

Example Calculation for Caldwell, ID Area.
3 bedroom home discharging 250 GPD.

WATER MASS BALANCE

Month	Precipitation Rate	Effluent Depth	ET	Δ Storage	Cumulative Storage	Saturated Bed Depth
	A (ft)	B (ft)	C (ft)	D (ft)	E (ft)	F (ft)
Oct.	0.086	0.087	0.232	-0.059	-0.059	0
Nov.	0.135	0.086	0.000	0.221	0.162	0.46
Dec.	0.142	0.089	0.000	0.231	0.393	1.12
Jan.	0.152	0.089	0.000	0.241	0.634	1.81
Feb.	0.118	0.080	0.000	0.198	0.832	2.38
March	0.122	0.089	0.167	0.044	0.876	2.50
April	0.108	0.086	0.327	-0.133	0.743	2.12
May	0.111	0.089	0.449	-0.249	0.494	1.41
June	0.088	0.086	0.544	-0.370	0.124	0.35
July	0.030	0.089	0.609	-0.490	-0.366	0
Aug.	0.031	0.089	0.497	-0.377	-0.743	0
Sept.	0.058	0.086	0.368	-0.224	-0.967	0

Start with the first month in which storage will be positive. In Idaho, that is usually October.